***“Seeing the Unseen”***

**Atom Structure**

**Past, Present and Future**

*Ann Hast – WMS Rapid City*

*Grade 6-8*

*Duration 5 days/class periods*

**Objectives:**

* Compare and contrast models of the atom throughout history and how they originated
* Understand the current model of the atom and that it is still evolving
* Engage in model building and making inferences
* Set the basics for delving deeper into particles (quarks)

**Standards:**

South Dakota Science Standards:

\*6.N.2.1: Students are able to pose questions that can be explored through scientific investigations.

\*6.P.1.1: Students are able to able to identify the subatomic particles that make up atoms.

\*6.S.1.1: Students are able to describe how science and technology have helped society to solve problems.

\*8.N.2.1.: Students are able to differentiate among facts, predictions, theory and law/principles in scientific investigations.

\*8.P.1.2.: Students are able to use the Periodic Table to compare and contrast elements.

NGSS Standards:

\*Disciplinary Core Ideas –

-PS1.A: Structure and Properties of Matter

\*Performance Expectations –

-MS-PS-SPM: Construct and use models to explain atoms…

-MS-ETS-ETSS: Provide examples to explain how advances in engineering have resulting in new tools and instruments for measurement, exploration, modeling and computation that enable new scientific discoveries…

\*Science and Engineering Practices –

-Engaging in Argument from Evidence

-Developing and Using Models

\*Crosscutting Concepts-

-Patterns

-Cause and Effect

**Big Ideas:**

\*Indirect Evidence can be used to learn about things that we cannot see.

\*The atom is the smallest particle you can have a substance **but** is itself made up of smaller particles which are in turn made up of smaller particles leading into the current study of matter in the universe.

\*Our understanding of atoms and matter is continually being revised.

**Materials:**

Teacher computer with projector/Smartboard

Student computers with Java (headphones)

Mystery Boxes

Rutherford simulation board, marbles, meter sticks, graph paper

Student copies of any worksheets you choose to use

Materials for model building (clay, cardboard, flashlights, mirrors)

Materials for SPM extension activity (landscape boxes, probes, sugar cubes, graph paper, colored pens)

Modeling the Hydrogen Atom Spectrum Analysis Worksheets- for extension.

**Engaging Activity: Day 1 (in classroom)**

**-Hands-on Mystery Boxes**: Each student has a box sitting on their desk when they come in. They are to guess what is in the sealed box. Discuss/share techniques used. How else could we use these techniques?

**-Rutherford Board** (labeled axis on sides): Students decide how to figure out what shape is under the board using the materials provided – marbles of various sizes. Graph paper, rulers. Discuss/modify.

-Rutherford Scattering Simulation (pHET) on projector – Discuss indirect evidence

<http://phet.colorado.edu/en/simulation/rutherford-scattering>

**Making Connections: Day 1 (*Homework Options)***

1. **Video Game – Play “Particle Pinball”**

<http://ed.fnal.gov/projects/labyrinth/games/codecrackin/index.html?name=Your+Name>

1. **Reading (homes w/out internet) - Worksheet Activity on Ernest Rutherford – pdf**

<http://education.jlab.org/beamsactivity/6thgrade/shapeofthings/index.html>

1. **Do Rutherford Scattering Sim. With worksheet**

<http://phet.colorado.edu/en/simulation/rutherford-scattering>

**Worksheet:** <http://phet.colorado.edu/en/contributions/view/3122>

**Exploration: Day 2 (in computer lab)**

**-Models of the Hydrogen Atom Simulation by pHET with/without accompanying Worksheet**

<http://phet.colorado.edu/en/simulation/hydrogen-atom>

**worksheet =** <http://phet.colorado.edu/en/contributions/view/3122>

**Formative Assessment: End of Day 2**

**-Molecular Workbench Tutorial with assessments– “Atomic Structure”**

**Students submit report in class folder or self-correct and follow path recommended**

**(Reinforcement, Proficient, Extension) tomorrow.**

[**http://mw2.concord.org/public/part2/atomstrk/page1.cml**](http://mw2.concord.org/public/part2/atomstrk/page1.cml)

**\*(Note: You need to have students download Molecular Workbench to their desktop and the teacher must set up folders – per class period – for students to submit their report/results to).**

**Differentiated Assignments: Day 3 and 4 (do activities in computer lab, discuss and share learning)**

**Reinforcement:**

**-“How Small is the Atom” video on TED**

<http://www.ted.com/talks/lang/en/just_how_small_is_an_atom.html>

-**Tutorial on Protons, Neutrons and Electrons**

<http://www.teachersdomain.org/asset/lsps07_int_theatom/>

**-Build an Atom – pHET Simulation**

<http://phet.colorado.edu/en/simulation/build-an-atom>

**Proficient:**

**-Build an Atom – pHET Simulation**

<http://phet.colorado.edu/en/simulation/build-an-atom>

**-What is an Isotope?**

<http://www.windows2universe.org/physical_science/physics/atom_particle/isotope.html>

**-Scanning Probe Microscopy Activity – Probe landscapes, record data on grid and model it with sugar cube/marshmallows (can build models at home).**

<http://mrsec.wisc.edu/Edetc/modules/MiddleSchool/SPM/index.html>

**Extensions:**

**-Repeat “Models of the Hydrogen Atom” pHET simulation but use the handout that emphasizes Spectrum Analysis.**

<http://phet.colorado.edu/en/simulation/hydrogen-atom>

**-An online tutorial on Quantum Mechanics and the Hydrogen Atom**

<http://universeadventure.org/fundamentals/popups/matter-dtrh-quantum.htm>

**-Math Extension using Indirect Evidence**

<http://www.lepp.cornell.edu/Education/rsrc/LEPP/Education/Lessons/Indirect_Measurement.pdf>

**Sanford Lab Connection: Day 5**

**Bell Ringer Opening Question:**

*If we believe that protons, neutrons, and electrons are made of even smaller particles, plus there are millions of other types of particles in our world, how can we now try to “see” them using their properties and indirect evidence?*

**a. Students each write their thoughts to the question and then get in groups and share their ideas. The groups take turns writing one of their ideas on the smartboard for a class discussion.**

**b. Teacher introduces the Sanford Underground Research Facility. If students are not familiar with the history, you can show the video “Deep Science” at the following website.**

<http://www.youtube.com/watch?v=As4flGTbzW4&list=UUye0h8GkTnqGf3HofMcWhbQ&index=2&feature=plcp>

**c. Introduce Nobel Prize winner Ray Davis. (also shown in the video) Tell his story found on the following site. Emphasis that he joins the line of all of the scientists who have refined our ideas of the atom and matter. Also emphasize that this work continues right here in the Black Hills!**

<http://www.sas.upenn.edu/home/news/davispics.html>

or Solving the Case of the Missing Neutrinos by John Bahcall.

<http://www.nobelprize.org/nobel_prizes/physics/articles/bahcall/>

**Photos =** <http://www.sns.ias.edu/~jnb/Papers/Popular/JohnRaypictures/johnraypictures.html>

**d. Discuss the two main experiments taking place underground at Sanford lab. After each, return to the bell ringer question and tie in the idea of studying the unseen through the use of indirect evidence.**

1. **The Lux Detector**



**VIDEO ANIMATION**

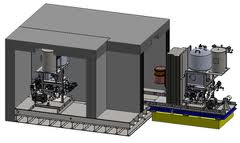
<http://luxdarkmatter.org/home.html>

***Overview- from Berkley LUX website-***

*The Large Underground Xenon (LUX) Experiment began with the construction and deployment of a 350 kg two-phase liquid/gas xenon dark matter detector and water shield, installed in May, 2012 in the Davis Cavern at the Sanford Underground Research Facility (formerly the Homestake Mine) in Lead, South Dakota.*

*A large detector is required to not only set such a sensitivity limit, but also to accumulate WIMP statistics in a reasonable time frame if a signal is detected. The LUX program will also help develop the technologies required for 1–10 ton dark matter detectors.*

*Liquid Xenon both scintillates and becomes ionized when hit by particles (i.e. photons, neutrons and potentially dark matter). The ratio of scintillation over ionization energy caused by the collision provides a way of identifying the interacting particle. The leading theoretical dark matter candidate, the Weakly Interacting Massive Particle (WIMP), could be identified in this way.*



1. **The Majorana Demonstrator**

*The project is named after Ettore Majorana, an Italian physicist who first speculated that a neutrino might be identical to its antiparticle.  Understanding the electrically neutral, subatomic neutrino particle, and how rarely it interacts with other matter, has become one of the most intensive physics research projects ever attempted.*

*The Majorana Collaboration is assembling an array of HPGe detectors to search for neutrinoless double-beta decay in76Ge. Initially, Majorana aims to construct a prototype module to demonstrate the potential of a future 1-tonne experiment. The design and potential reach of this prototype Demonstrator module are presented.*

**\*\*Cumulative Activity\*\***

**A fieldtrip to Sanford Underground Research Facility**

**Contact Peggy Norris at** [**PNorris@sanfordlab.org**](mailto:PNorris@sanfordlab.org)

**Cumulative Assessment: Introduce at the End of Day 5**

**-Product based assessments: (Have choices for various learning modalities) Examples:**

\*Design a blueprint of your own detector.

\*Make an model of one of the proposed atomic structures we studied. Credit the scientist who proposed the idea and write a description of how they came up with this idea.

\*Make a PowerPoint on a present topic that is on the cutting edge of particle physics.

**NEXT LESSON – QUARKS!**

**Lesson Evaluation and Notes**